Columbia/Snake River Mainstem TMDL

Lake Roosevelt Water Quality Council

March 19, 2002

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Agenda

Part 1 - Overview of the Temperature TMDL process to date.

Part 2 - Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

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Part 1

Overview of the Temperature TMDL process to date.

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TMDL Development

- Model Development ☸
- Problem Assessment ☸
- TMDL 🗁

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Why Do We Need A Model?

- **We need to estimate temperatures under un-impounded conditions for which measurement data is scarce**
- **We have conflicting measurements**
- **We do not have measurements at all river locations of interest**
- **We need to estimate influence of different sources**

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Model

- RBM 10
- One Dimensional Energy Budget Mathematical Model.
- Results:
  - Cross sectional averaged temperature
  - Daily or hourly average temperature

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Model Development

- **Developed for the Columbia/Snake TMDL**
- **Peer Reviewed**
- **Intensive Regional Review - industry, contractors, federal agencies.**
- **Numerous public meetings, two public workshops**

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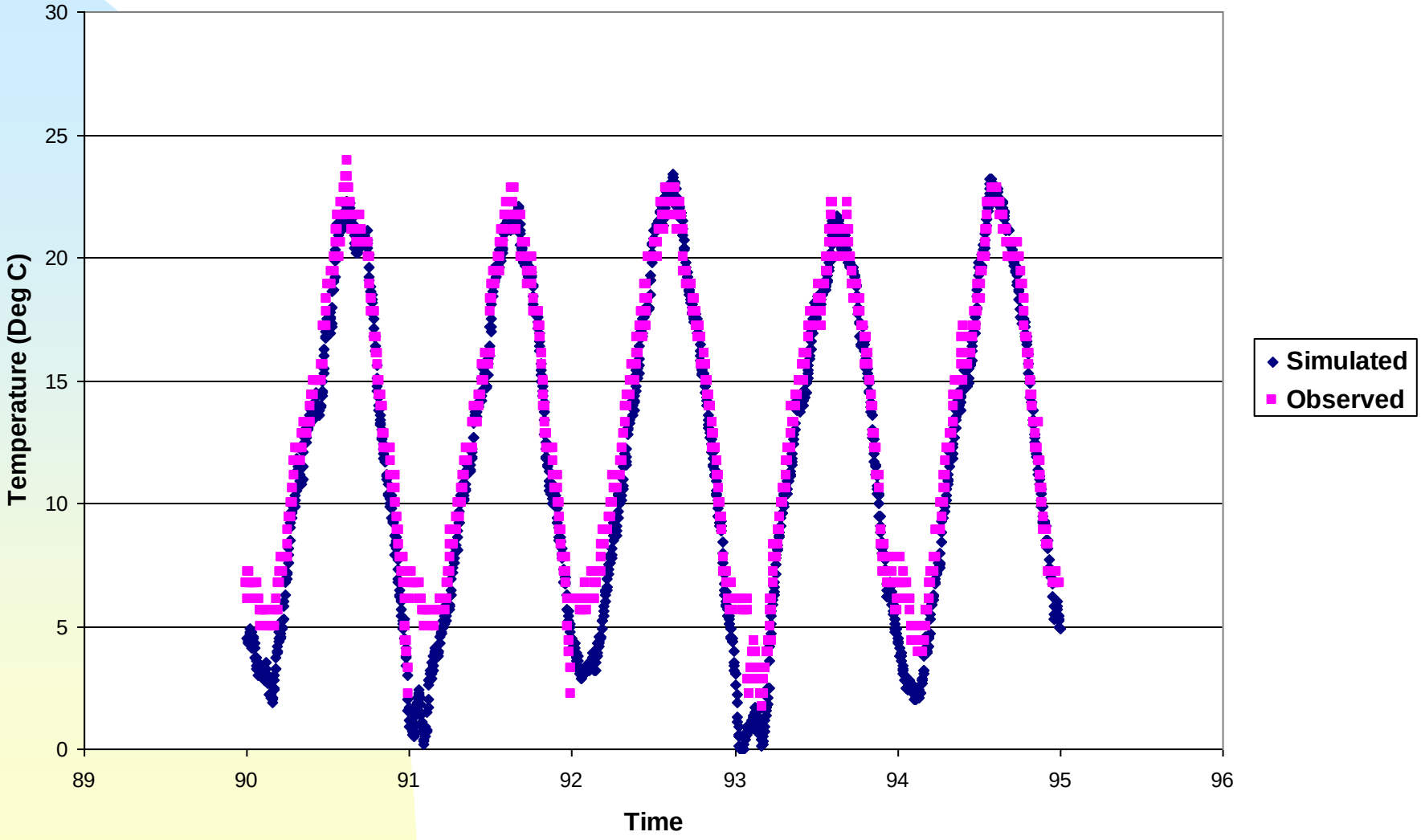
Simulated and Observed Temperature at Bonneville 1990 - 1994



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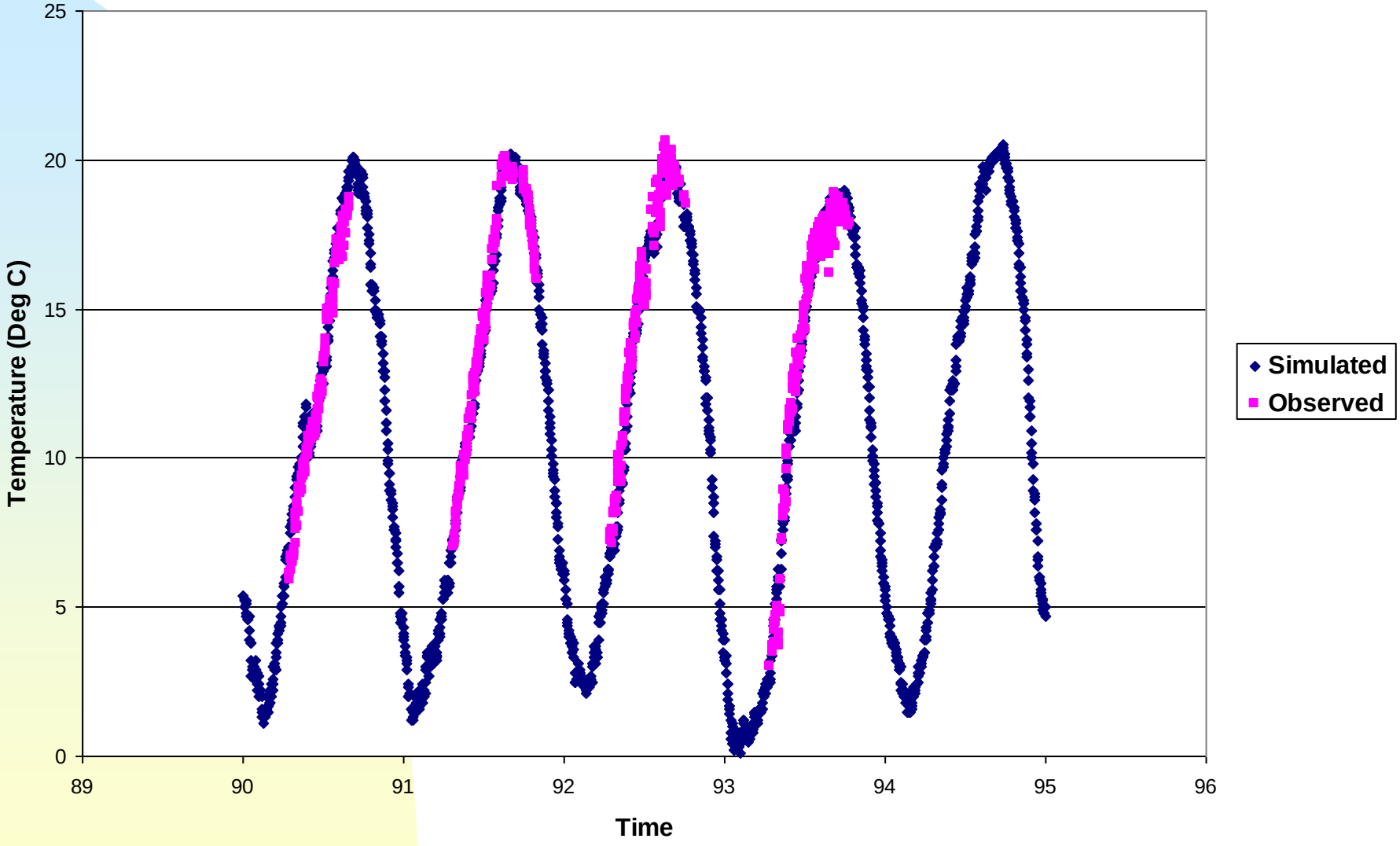
Simulated and Observed Temperatures at Grand Coulee 1990-1994



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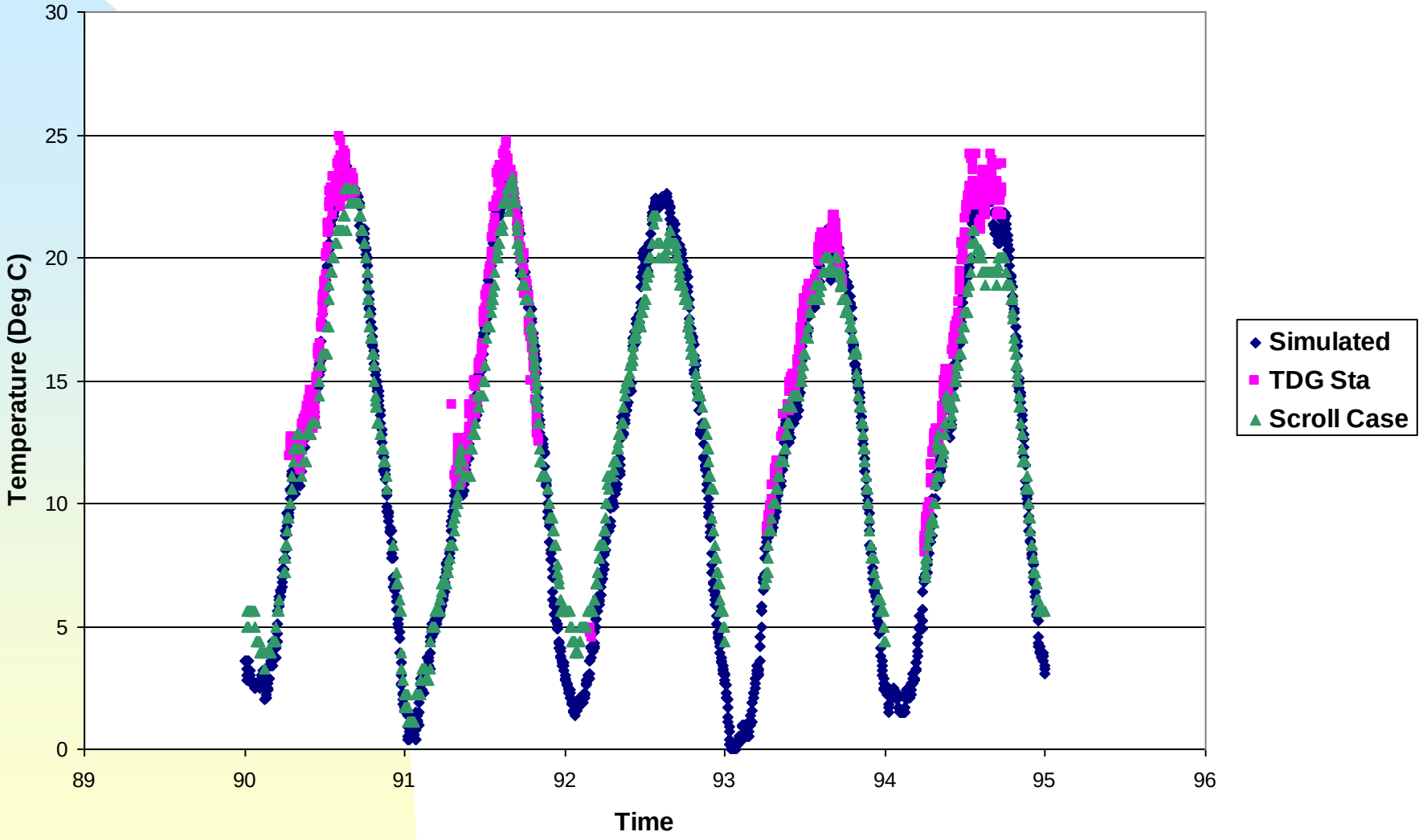
Simulated and Observed Temperatures at Ice Harbor 1990 - 1994



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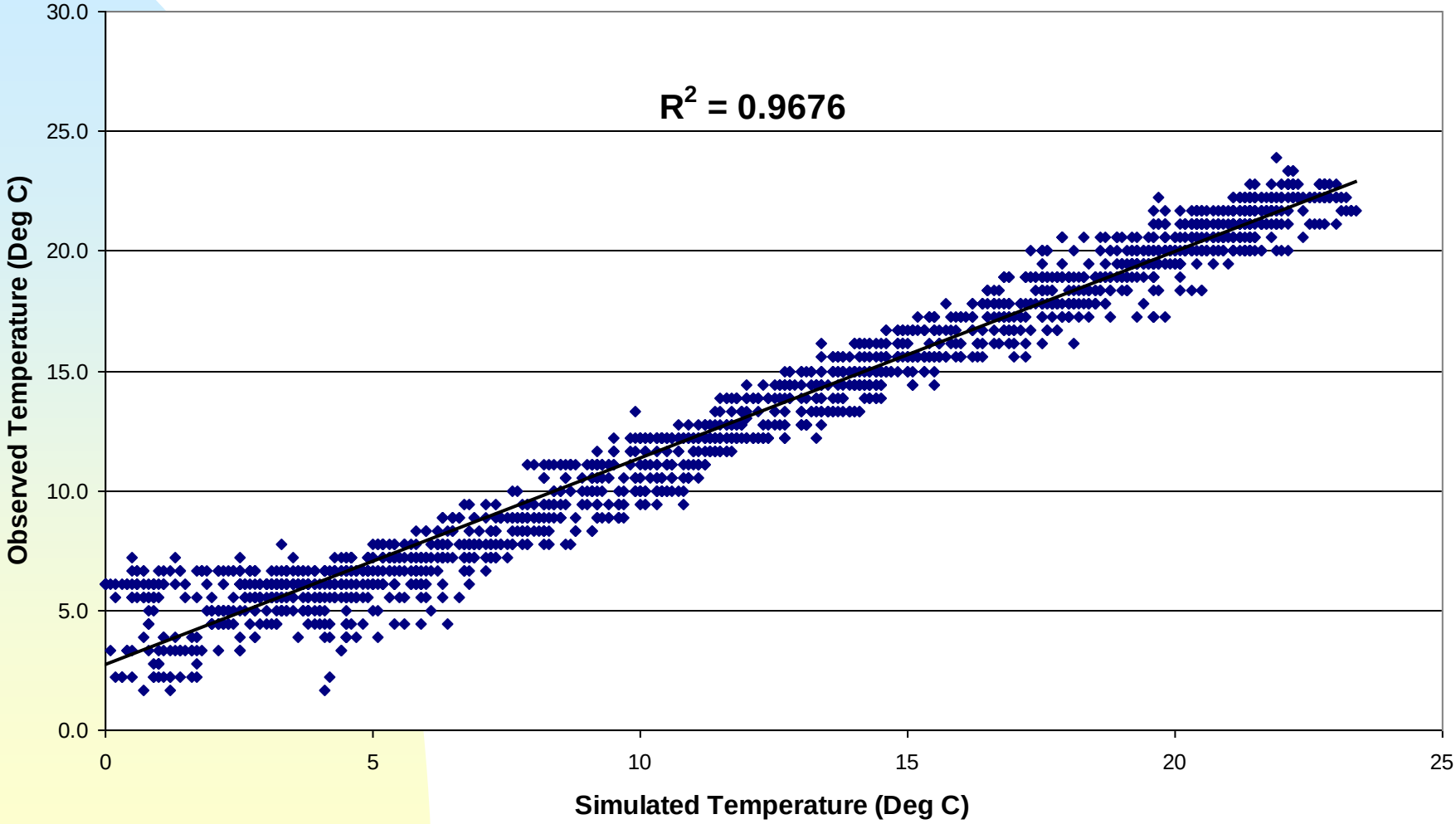
Regression of Observed on Simulated Temperature at Bonneville Dam 1990-1994



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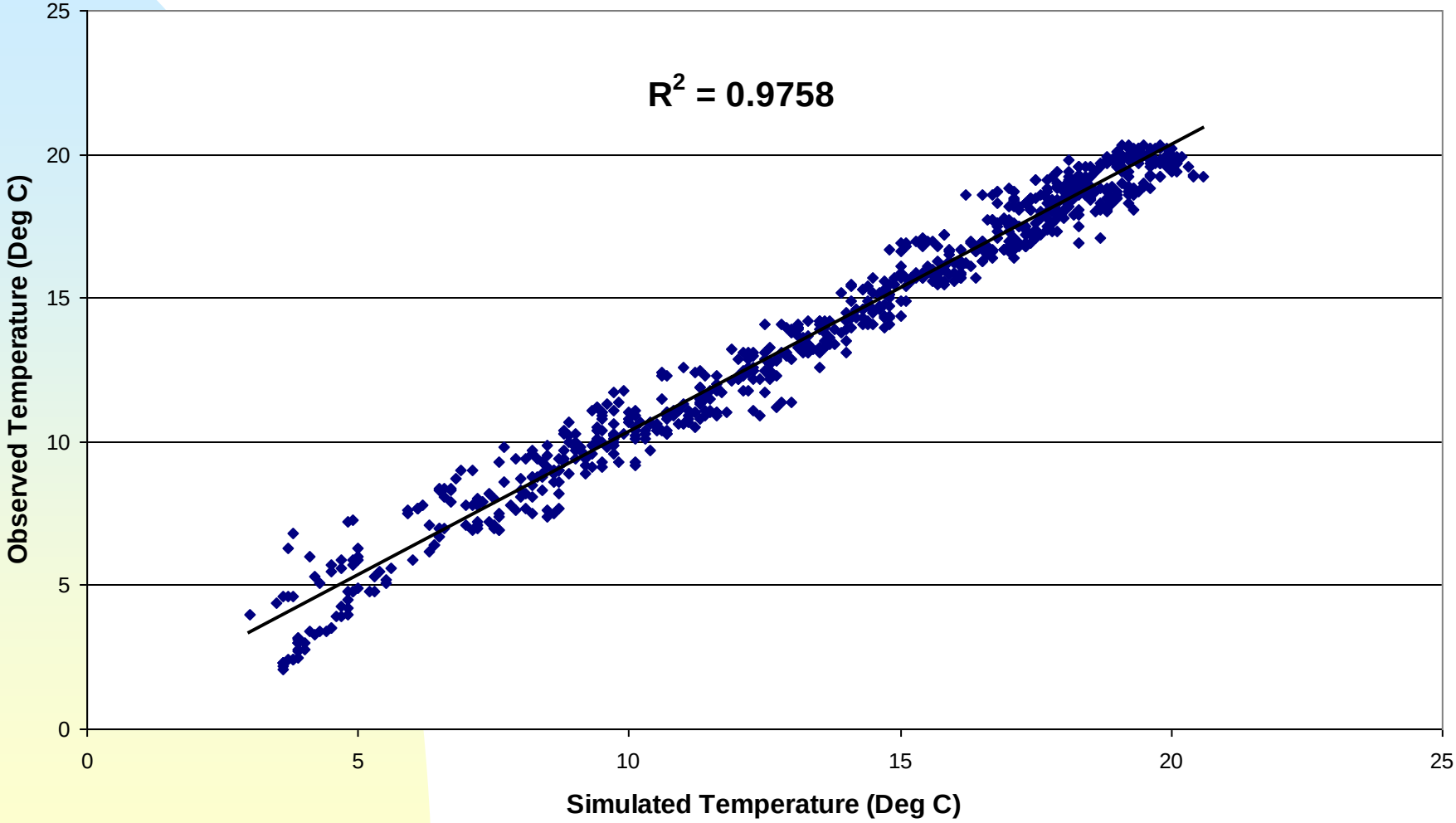
Regression of Observed Temperature on Simulated Temperature
Grand Coulee Tail Race 1990-1994



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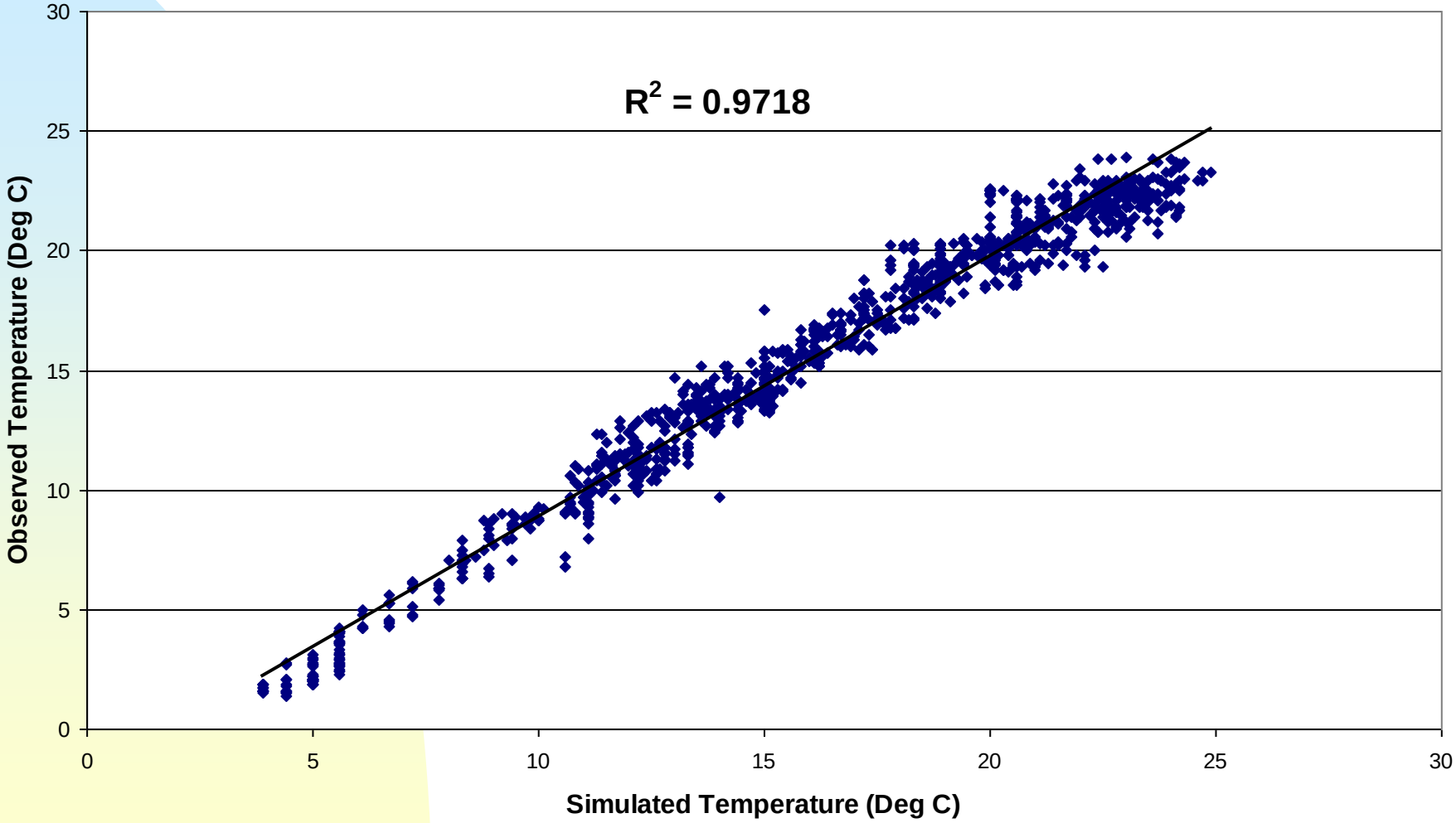
Regression Observed Temperature on Simulated Temperature at Ice Harbor 1990-1994



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RBM 10 Error Estimates

Location	*Mean Difference (Obs – Sim)*	*Standard Deviation*
Snake River @ Ice Harbor	*0.59**	*1.1**
Columbia River @ Grand Coulee	*-0.23**	*0.73**
Columbia River @ Bonneville	*1.0** *0.84***	*1.1** *1.18***

- * 1990 – 1994
- ** 1970-1997

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Error Estimates From Other Studies

RISLEY (1997) - Tualatin River

Max Mean Difference = 3 Deg C

Mostly < 1 Deg C

BATTELLE-MASS1 (2001) - Columbia River

RMS Error = 0.59 - 1.52 Deg C

HDR/PORTLAND STATE/IPC (1999) - Snake River

AME = 0.6-2.3 Deg C (1992 data)

AME = 0.5-2.0 Deg C (1995 data)

CHEN (1996) - Grande Ronde River

Error = -2.20 - 8.28 Deg C (Summer Max)

Error = -1.21 - 7.69 Deg C (Avg 7-day Max)

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Problem Assessment

Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

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Problem Assessment

1) Does temperature exceed the Water Quality Criteria?

2) Does temperature exceed the Water Quality Criteria due to human activities?

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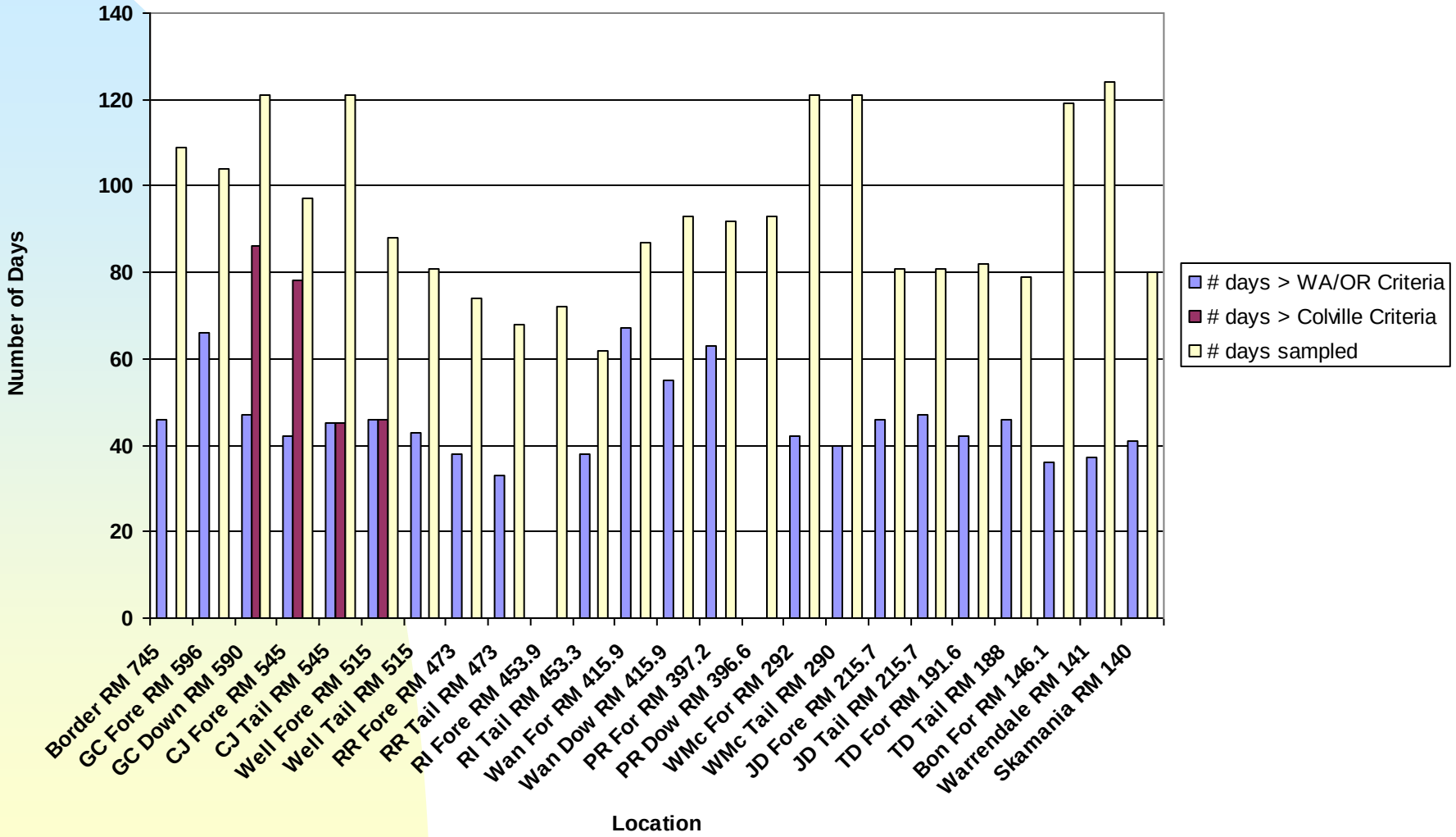
July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



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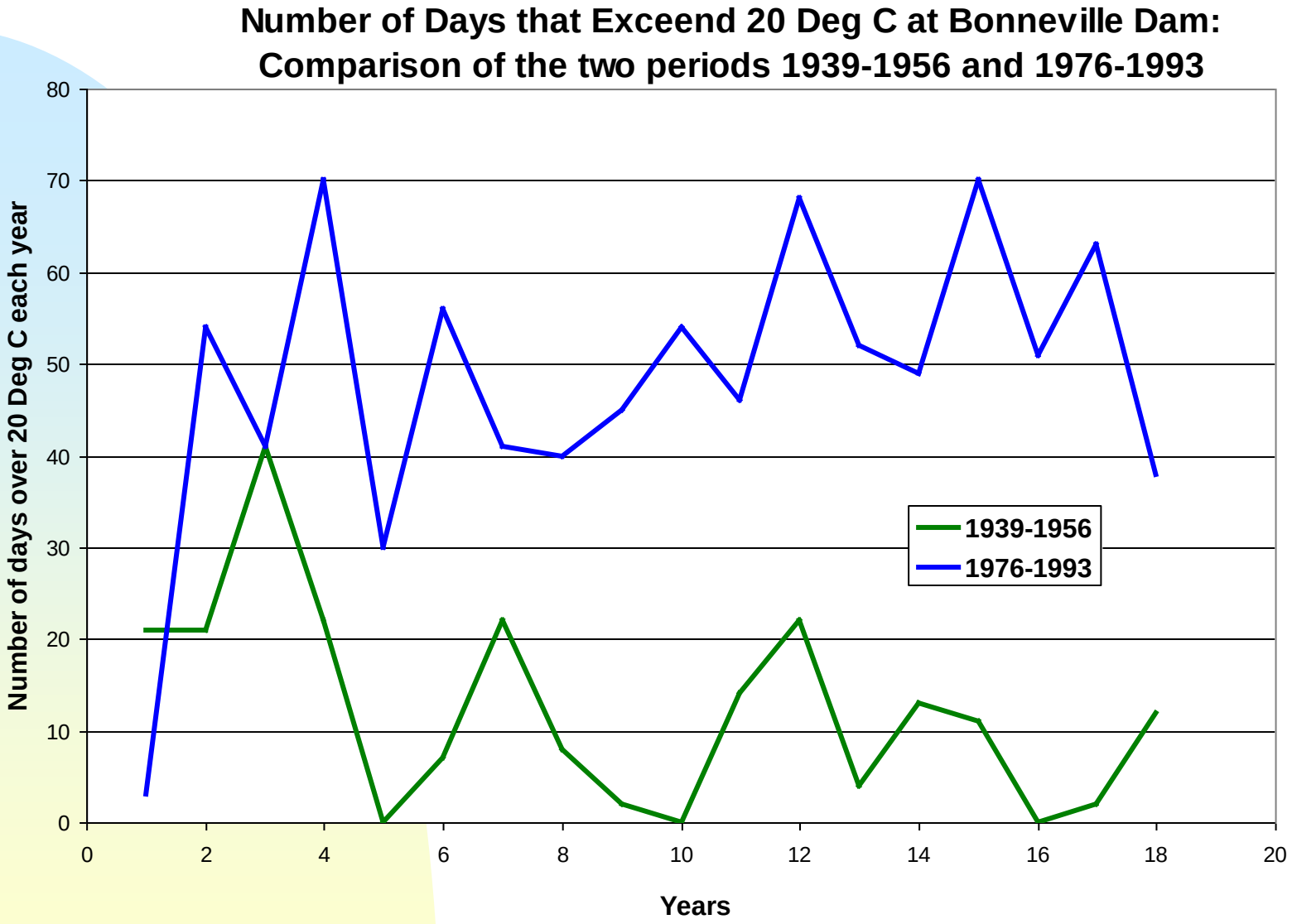

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Problem Assessment

- A significant cause for the altered temperature regime in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.

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Part 2

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

1) **Determine Target Temperatures**

2) **Establish Loading Capacity**

3) **Allocate Available Load**

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Important Points

- Site Potential Temperatures
- Target Temperatures = Average Site Potential + increment from WQS
- The downstream WQS are more restrictive and drive the TMDL target temperatures in the mid-Columbia.
- The Load is expressed as Temperature
- The Loading Capacity = the Target Temperature
- Temperature available for allocation is the WQS increment.

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Water Quality Standards

The WQS for this TMDL are the natural temperatures of the Columbia and Snake main stems plus small incremental increases due to human activity.

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Water Quality Standards

Colville Standard for Lake Roosevelt:

"Temperature - shall not exceed 16 C due to human activities. Temperature increases shall not at any time, exceed t=23/(T+5).

When natural conditions exceed 16 C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 C."

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Water Quality Standards

Natural stream temperatures for this TMDL are those that would occur in the main stems within the TMDL study area in the absence of human activity within the main stems in the study area.

They are termed <u>site potential</u> temperatures in this TMDL.

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Columbia River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Canadian Border to Grand Coulee			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Grand Coulee to Chief Joseph			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Chief Joseph to Priest Rapids			
	18 C	SP + 28/(T+7)	SP + 0.3 C
Priest Rapids to OR/WA Border			
	20 C	SP + 34/(T+9)	SP + 0.3 C
OR/WA Border to the Mouth			
	20 C	**SP + 1.1 C**	**SP + 0.14 C**

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Determine Target Temperatures

1. Determine the Site Potential (SP) Temperatures

2. Apply the WQS for each reach.

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Site Potential Temperatures

The site potential temperatures vary temporally and geographically. They vary from day to day and from year to year. They also vary along the longitudinal axis of the rivers.

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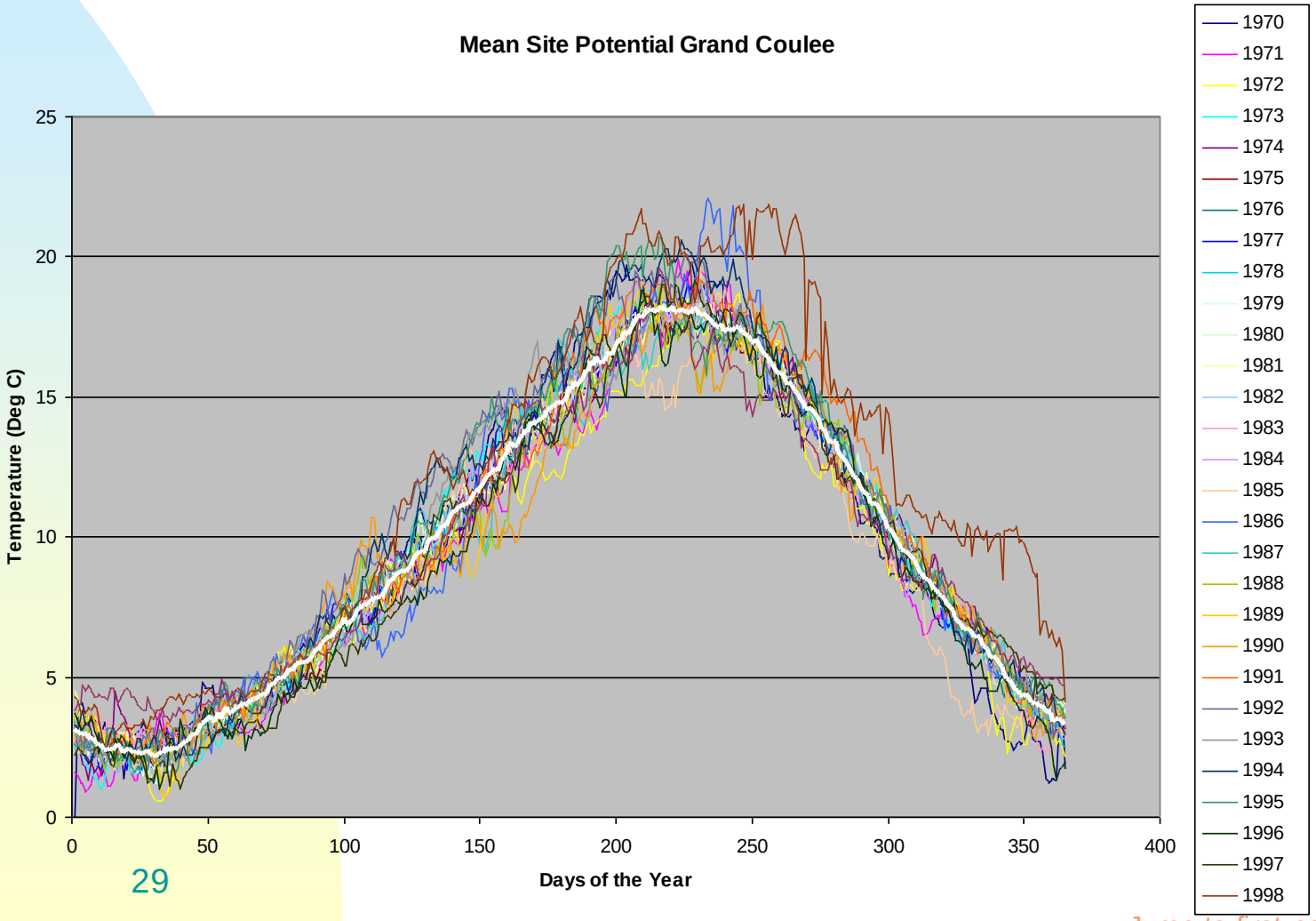
To account for this variability we utilize the mean daily site potential temperatures based on 30 years of simulations using actual weather and flow data.



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Target Temperatures

- Apply the WQS to the Average SP Reach by Reach.

- SP in the formulas = the 30 year average site potential for each day of the year.

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Target Temperatures

If we apply the WQS reach by reach to determine the target temperatures reach by reach we will exceed the target temperatures in the downstream reach.

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Target Temperature

•We need to meet the more stringent WQS: in this case the standards in the lower reach along the border.

•So we need to determine the target temperature in the upstream reaches that will allow achievement of the target temperature in the lower reach.

•Ie: We have to allocate temperature among the upstream sources.

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Target Temperatures

There are many ways to allocate the target temperature:

1. Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.

2. Base the incremental increase for a reach on impacts to temperature in the reach. Eg larger reservoirs get bigger increments.

3. Give the sources above the OR/WA border a "bubble allocation". The target temperature at the beginning of the reach has to be .14 above SP. Let the sources allocate that among themselves.

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Target Temperatures

We have completed the first example approach: **Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.**

When Site Potential is less than the Criterion:

incremental increase in each reach is 0.15 C

When Site Potential Exceeds Criterion:

incremental increase in each reach is 0.02 C

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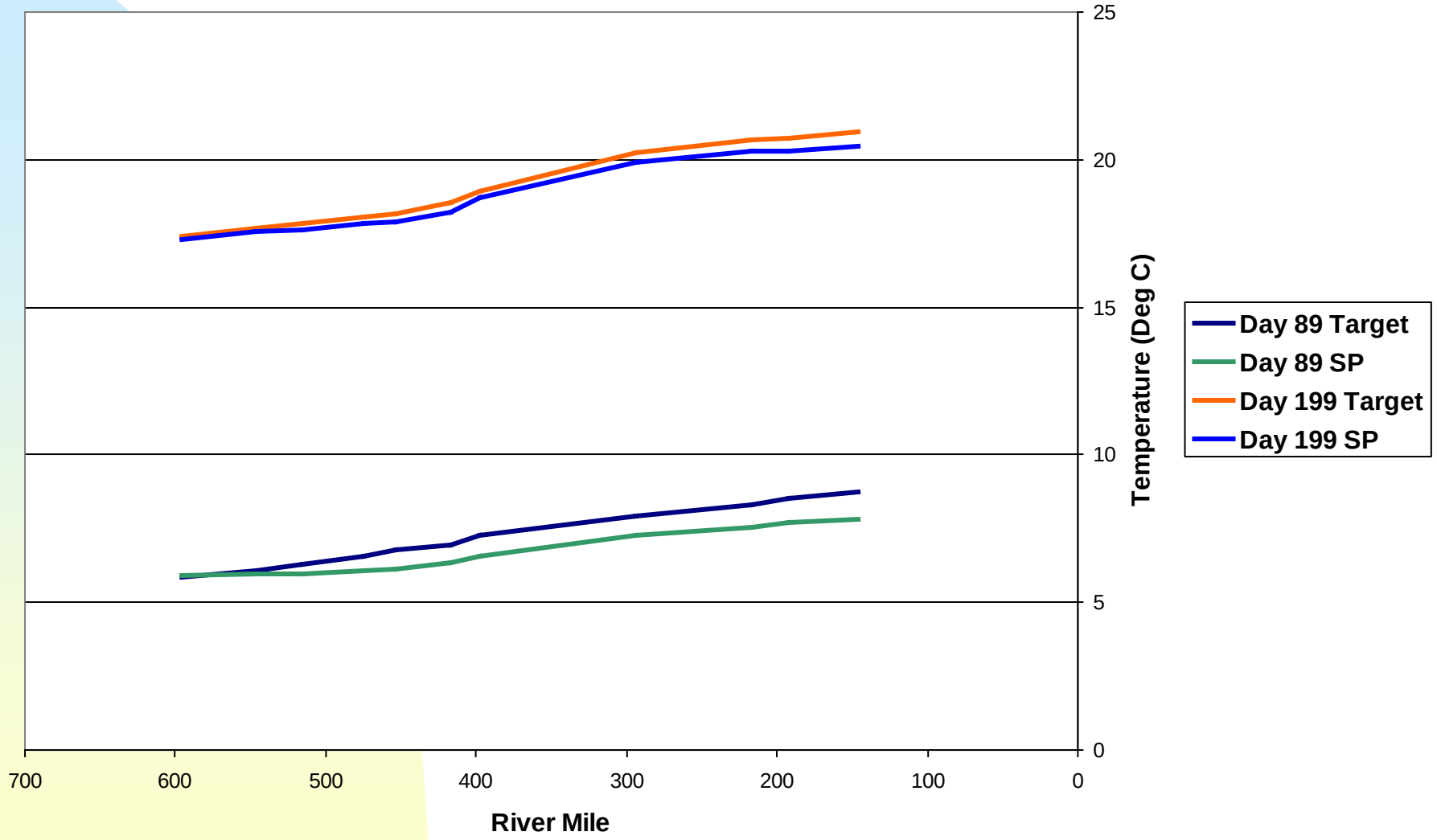
Target and Site Potential Temperatures along the Columbia



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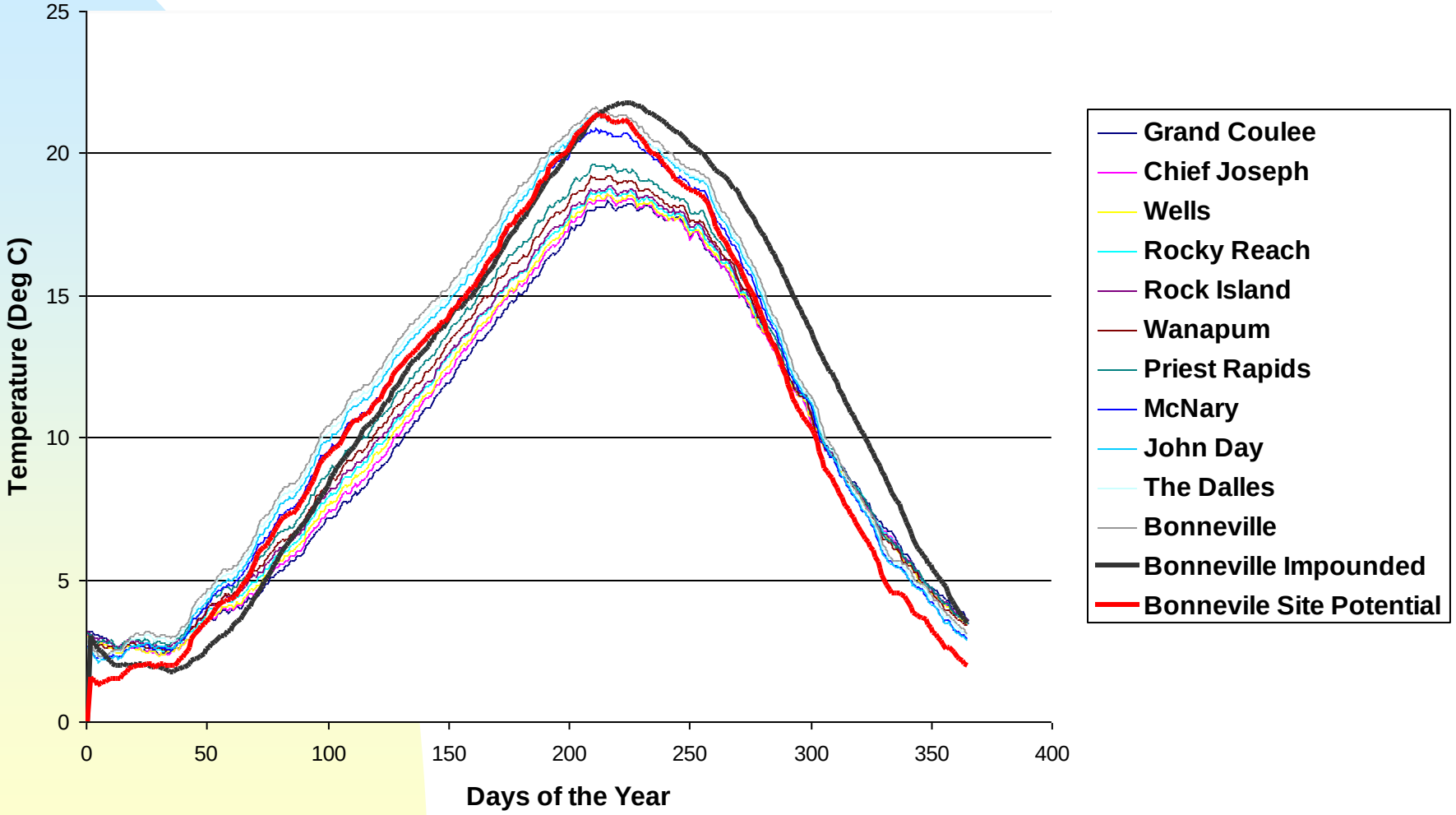
TMDL Temperatures at the Target Sites with Bonneville Site Potential and Impounded Temperatures



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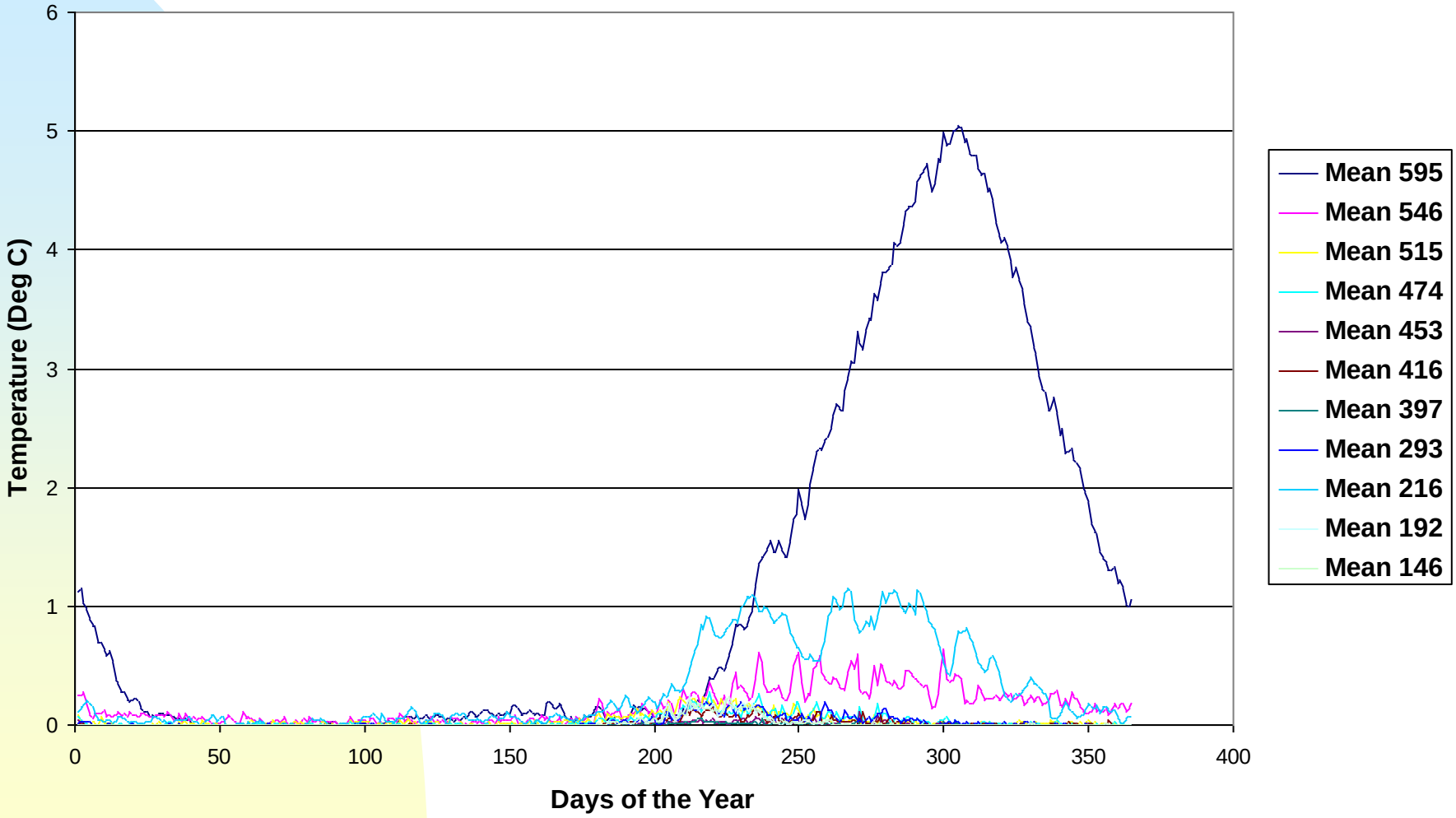
Temperature Improvements Needed at Each Columbia River Target Site



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Part 2

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

1) **Determine Target Temperatures**❁
2) **Establish Loading Capacity**
3) **Allocate Available Load**

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Establish Loading Capacity

- Loading Capacity in this TMDL is in terms of Temperature rather than thermal load.
- Temperature is being used as "another appropriate measure" as per the regulations.
- Thermal load is not used because the dams are the most significant causes of temperature change but they do not discharge a thermal load to the river and they can alter load without affecting temperature.

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Establish Loading Capacity

For this TMDL the Loading Capacity is the Target Temperature.

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Allocate Available Load

The load available for allocation to dams, point sources, non-point sources, and future growth is the incremental increase allowed at each target site to achieve the target temperature:

- 0.02 C when the SP > criteria
- 0.15 C when the SP < criteria

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Allocation Table - Chief Joseph

Day	Upstream LC (°C)	LC (°C)	Increment (°C)	Dams Allocation (°C)	Other Sources (°C)	Future Growth (°C)
89	5.89	6.04	.15	.14	.005	.005
199	17.62	17.64	.02	.01	.005	.005

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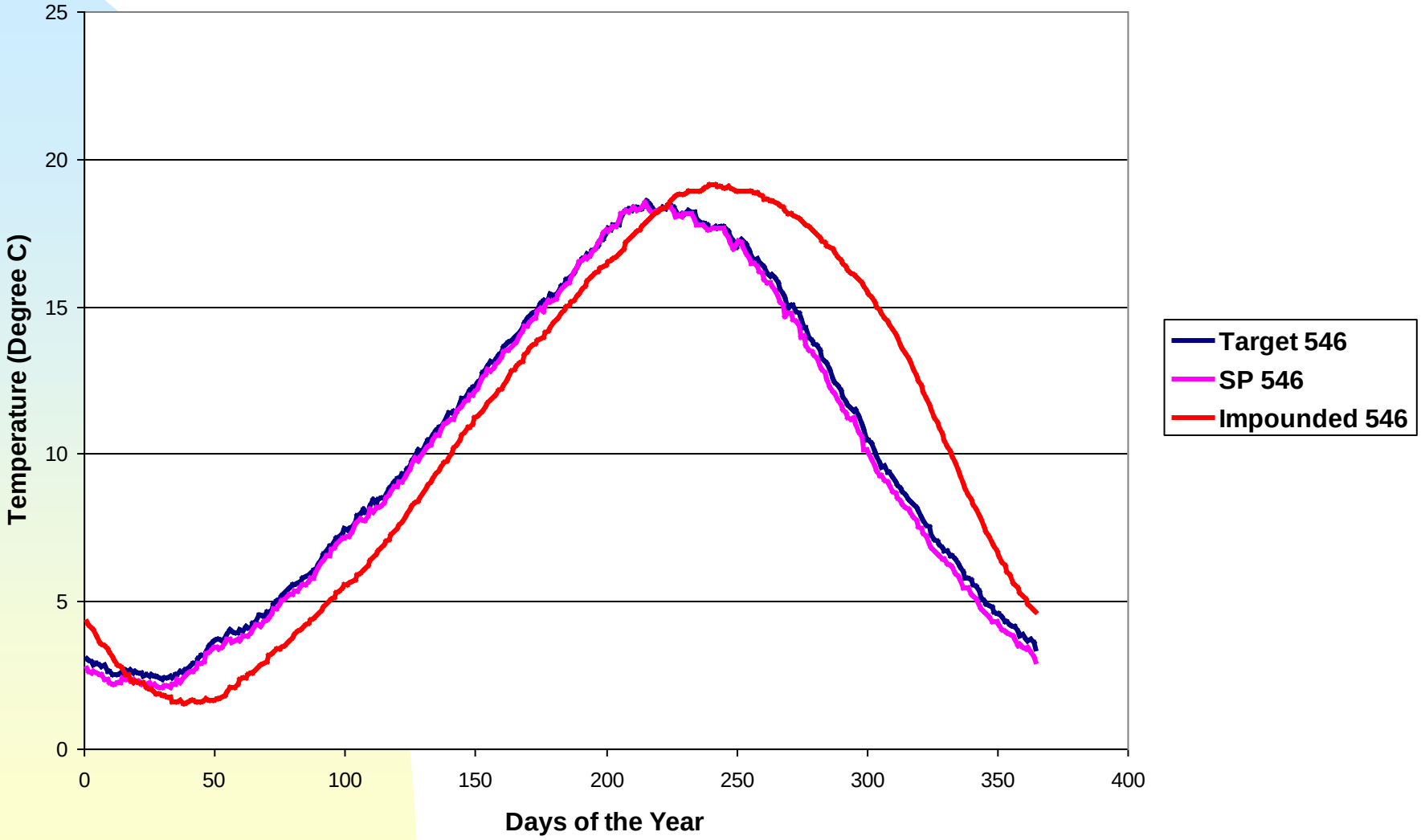
Chief Joseph Target, Site Potential and Impounded Temperatures



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Allocate Available Load

- What do these small allocations mean?
- Do they pass the laugh test?

- They mean that essentially no measurable increase in temperature due to human activity is allowed at each target site.
- There is sufficient loading capacity for existing point sources and some future growth.

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Measuring Compliance

Long Term System Level Compliance:

•Compliance with the target temperatures. That is, mean water temperature at the target sites equals the target temperatures.

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